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Organic and inorganic whole system metabolism in two acidified coastal systems in Ireland

Maria Teresa Guerra and Carlos Rocha

Trinity College Dublin, College Green, Dublin 2, Ireland (guerram@tcd.ie)

Organic and inorganic whole system metabolism for two Irish coastal areas were compared to evaluate carbonate system resilience to acidification. The two systems are characterized by contrasting watershed input types and composition. Kinvara Bay is fed by Submarine Groundwater Discharge (SGD) derived from a karstic catchment while Killary Harbour is fed by river discharge draining a siliciclastic catchment. Freshwater sources to sea have distinct Total Alkalinity (TA) and Dissolved Inorganic Carbon (DIC) concentrations, higher and lower than the open ocean, respectively, but both evidence seasonally variable low pH, ranging from 6.20 to 7.50. Retention of TA and DIC was calculated for the two areas using LOICZ methodology. In Kinvara bay, annually averaged retention of DIC was greater than for TA (5×10^4 and 1.5×10^5 mol d⁻¹), suggesting the system is acidifying further. Conversely, Killary Harbour shows negative TA and DIC retention, with DIC:TA <1, suggesting an internal buffer against ocean acidification is operating.

Net Community Production (NCP) was calculated for both systems using Dissolved Oxygen data. Subsequently, we estimated Net Community Calcification (NCC) from the ratio between TA and DIC. NCP was always positive in Killary Harbour with an average of 318 mmol O₂ m⁻² d⁻¹ (equivalent to 89 mol C m⁻² y⁻¹). However, Kinvara Bay shows relatively lower positive NCP in spring and summer (average of 46 mmol O₂ m⁻² d⁻¹), but negative NCP in autumn and winter. Therefore, Kinvara Bay's Total Organic Carbon (TOC) production was low, at ~21 g m⁻² y⁻¹ and not enough to overcome acidification driven by the SGD source composition. These results emphasize the complexity of interactions between the drivers of coastal acidification rate, affecting our ability to accurately assess the resilience of the carbonate system in these areas to ocean acidification pressure in the future.